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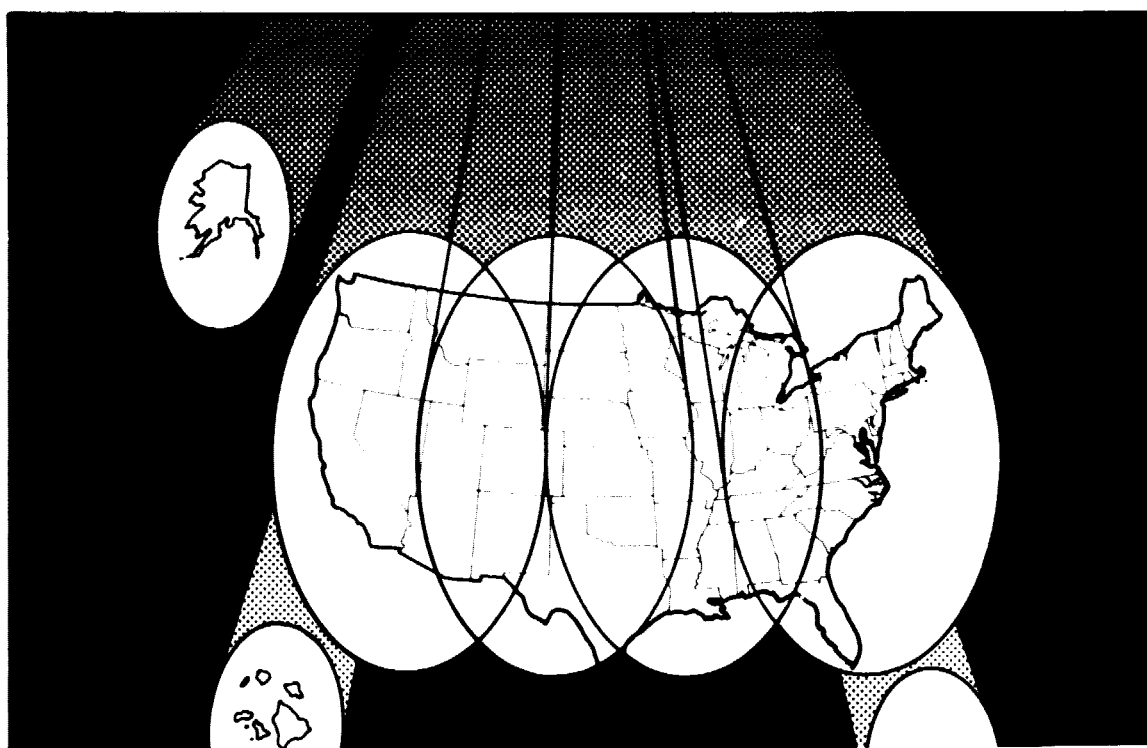
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February, 1977

A PUBLIC SERVICE COMMUNICATIONS SATELLITE



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COMMUNICATIONS SATELLITE USER BROCHURE
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BACKGROUND

The purpose of this brochure is to describe the capabilities of a proposed communications satellite that would be devoted to experiments and demonstrations of various public services.

A survey form is included to enlist an expression of interest from persons who might be potential experimenters.

The National Aeronautic & Space Administration (NASA) was actively involved in the development of communications satellite technology from its inception until January 1973. During that period NASA developed several low-orbiting satellites as well as the first geostationary communications satellite, Syncom. This geostationary satellite led to the commercial implementation of both new international communications satellites (Intelsat) and domestic communications satellites. NASA pursued the development of technology with the Applications Technology Satellite (ATS) series of which ATS-1, -3, -6, are still being used to perform satellite communications experiments and demonstrations. NASA cooperated with Canada in the development of the Communications Technology Satellite (CTS) which is also being used for experiments and demonstrations.

On January 5, 1973 NASA announced its intention to withdraw from communications satellite research and devel-

opment and leave that pursuit to the private sector. NASA indicated its belief that the technology had matured to the point of commercial exploitation so that future technological developments could be undertaken by private industry.

Since 1973 a number of organizations have questioned the premise on which the NASA phase-out decision was based and have recommended that NASA reconsider its policy and reestablish a communications satellite research and development program.

While NASA management considers these recommendations, a Public Service Communications Satellite study has been undertaken at the NASA Goddard Space Flight Center (GSFC) to define the problems and opportunities of a renewed NASA role and the form such NASA involvement should take.

The concept that has evolved has resulted from careful consideration of experiments that have already been undertaken on existing satellites, information obtained at a Users Requirements Workshop¹ held in October 1976, and other information.

Comments would be welcome on the extent to which this concept is responsible to user needs and changes which might be desirable.

OPPORTUNITIES

The United States has failed to exploit civilian communications satellite technology already developed at taxpayers' expense. This technology could be applied now to the betterment of life on earth. Citizens who reside in remote regions do not enjoy the quality of public services available to those in more densely populated areas. There are people in the United States without access to the normal communications services (telephone and television). There are people in thinly populated rural areas that lack the services of medical professionals enjoyed by urban residents. There are people in remote areas that receive inferior educational services. During times of emergencies and disasters, communications for warning and coordinating are often inadequate. Some opportunities are shown in Figure 1.

One opportunity for a public service communications satellite system is the direct delivery of health services. Spiralling costs, lack of public confidence, archaic practices, and increasing demands for greater service from an

overburdened health care delivery system have set the stage for a potential future crisis in health care. The application of communications satellites could eliminate some and ameliorate many of these problems. The use of satellites could result in better emergency medical services in rural areas, better utilization of expertise in large urban medical centers, the wide broadcast of preclinical sciences to student audiences on a regional basis, implementation of a continuing medical education system, the availability of expert consultation in medical specialties for the rural primary care physician, the rapid daily transmission of data and the transmission of advice from a remote specialist to the emergency medical technician at the scene for real-time decision making.

A public service communications satellite system offers the potential for increasing the delivery of education services. Productivity losses exist at all levels of education with fewer students, more teachers, more administrators and in-

¹ Wolff, Edward A. (Ed.), *Public Service Communications Satellite User Requirements Workshop, Final Report*, NASA Goddard Space Flight Center, October 1976.

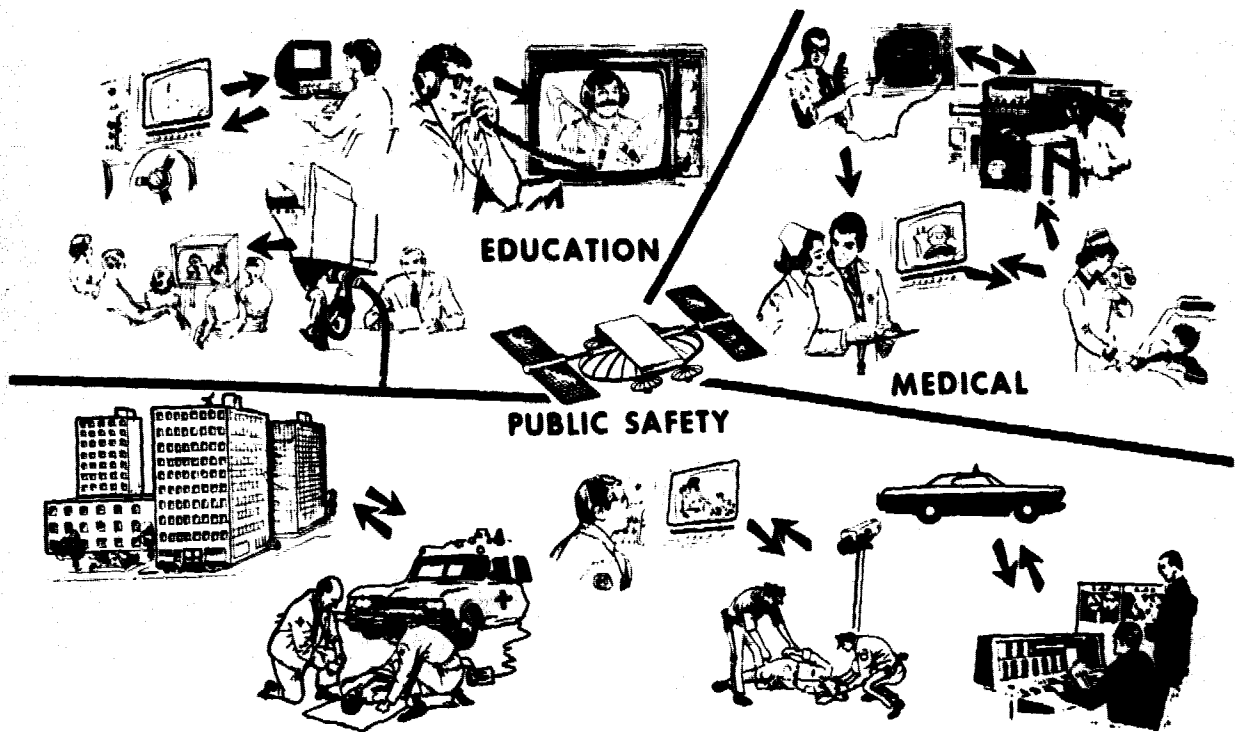


Figure 1. Opportunities

creased pay for school personnel with no comparable increase in student test scores. Direct reception from communications satellites has the potential for increasing teacher effectiveness and broadening the spectrum of educational opportunities.

The use of satellite techniques holds tremendous promise for increasing the effectiveness of public safety personnel by enabling more rapid response and coordination to emergency situations. Small portable, mobile, and hand-held communication devices are an essential ingredient for efficient services for ambulances, police, fire and rescue vehicles.

Specific health care communications requirements include voice broadcasting for patient and community health education; two-way voice interaction for doctor-patient communications and emergency mobile medical communications; data transfer for computer data bank files of patient records and medical practice information in fields such as epidemiology and pharmacology; and broadcast television for professional and para-professional education, teliagnosis and communications between physicians, health care centers and patients. Confidentiality is required for many applications.

Education communications requirements include audio broadcast for students, teacher training, and continuing education; data transfer for the transfer of students records, student instructional material and computer aided instruction; television broadcast for classroom students, in-service teacher training, occupational and con-

tinuing education, education of the handicapped, mass distribution of professional society meeting materials, and inter-school teleconferencing; two-way interactive television for students requiring special instruction and teacher-educator collaboration.

Public safety communications requirements include voice broadcasting for disaster alerting and safety education; two-way audio for emergency mobile communications; data transfer for transferring criminal history files, criminal justice planning, intelligence and laboratory data, fingerprints, mug shots, and administrative information; television broadcasts for remote area self-protection and safety training, disaster training and other in-service professional training; and two-way video for surveillance of special situations. Many of these applications require confidentiality and secure communications.

State and local governments require radio and television broadcasts for education of government personnel and the public. Two-way radio is required to coordinate emergency situations. Data transfer is required for multi-agency and multi-state access to data banks. Arraignment of people in locations remote from the courts can save both energy and manpower.

Library services require radio broadcasts for public information transfer among users; data transfer for access to computers and large data banks; and television broadcasting for public instruction, library training and extension education.

PROPOSED CONCEPT

The goal is the realization of operational commercial satellite public services.

The NASA program will provide the technology and mechanism for demonstrating and evaluating communications with small affordable stationary, portable, and moving ground terminals. The stationary terminals will serve the health, education and other public services provided by federal, state and local government agencies and nonprofit organizations. Portable terminals could be set up during emergencies and disasters. The mobile terminals would serve moving vehicles for emergency medicine, safety, and law enforcement needs.

The system concept has been developed to provide communications between any two points in the United States with both fixed and moving terminals on a continuous twenty-four hour basis. The communications available would include two-way video service between the stationary terminals and two-way audio service between the mobile terminals.

The system concept has been developed in a manner that is compatible with the capabilities of realizable technology and with the existing spectrum regulations.

The system concept based on the user requirements for stationary terminals includes operation at Ku-Band (14 GHz up, 12 GHz down), the use of a 1.8 m diameter earth terminal antenna, use of 100 W spacecraft traveling wave tube transmitters, and simultaneous coverage of the United States using four regional beams for continental United States plus spot beams for Alaska, Hawaii and Puerto Rico. In addition, two movable spot beams would be provided for special regional experiments. Each regional zone beam would utilize a 100 W transmitter while the spot beams would be served with 30 W transmitters. The ground station would utilize a 200 W transmitter for transmission of a video signal and a 10 W transmitter for audio. The ground receivers would have approximately 600°K noise temperatures.

The services for moving terminals would be implemented at UHF (823 MHz up, 868 MHz down). The mobile terminal

would have an omnidirectional antenna and a 10 W transmitter. The spacecraft would have an antenna with a continental U.S. beam and a 300 W transmitter.

This system concept requires the development of some new technology. Among the more significant developments are the design and realization of low-cost ground terminals to minimize the entrance fee for new satellite communications users. The 860 MHz land mobile service is a space capability not presently available. Multiple access and modulation studies and technique development are required to accommodate a large number of low duty cycle users for this mobile service. Public safety users require use of secure communications techniques.

The Ku-Band communications between stationary terminals also requires the development of low-cost ground terminals. Beam switching will be implemented so that uplink signals into any one of the beams can be rebroadcast to any one or more down-link beams. A beam switching or scanning technique will be required to move the regional spot beams over the U.S. Multiple access and thin route techniques will be needed to accommodate rural telephone service. Telemedicine users require implementation of privacy techniques.

These communications services will require the development of some spacecraft technology. The simultaneous operation of all transmitters will consume over 2 kW of dc power. A Ku-Band antenna with surface tolerances of the order of 2 mm and a diameter of approximately 2 m is required. The UHF antenna will have an elliptical aperture approximately 5 by 10 meters. Precise attitude control and station keeping (0.05°) will be needed to permit the stationary ground terminals to remain unattended in a fixed position.

The proposed system concept is shown in Figure 2 and additional technical details are given in the appendix. While NASA is developing the technology required to implement this system, users will be developing their institutional arrangements for the experimentation and will be developing the software required for experiments and demonstrations.

SPACE EXPERIMENT CAPABILITIES

The proposed Public Service Communications Satellite will not be available for user experimentation for several years. If it is requested by NASA and approved by Congress in the fiscal year 1979 budget (which is the next opportunity) it would probably not be launched until 1982. Meanwhile, users can begin experimentation on the existing satellites (ATS-1, -3, -6, and CTS). The existing satellites all have some limitations which need to be understood when considering utilizing them for experiments and demonstra-

tions. Some of the previous experimental activities are shown in Figure 3.

ATS 1 and 3

The Applications Technology Satellites 1 and 3 offer the capability of performing experiments with fixed and mobile VHF terminals.

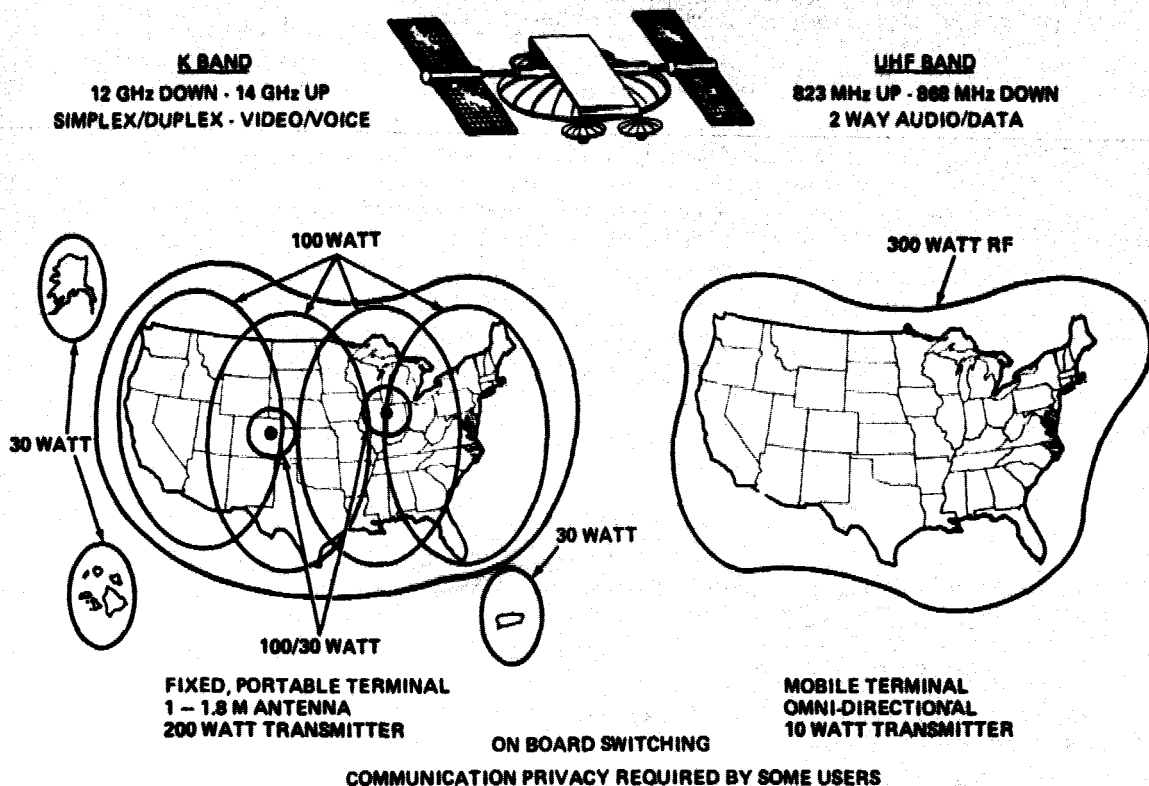


Figure 2. System Concept

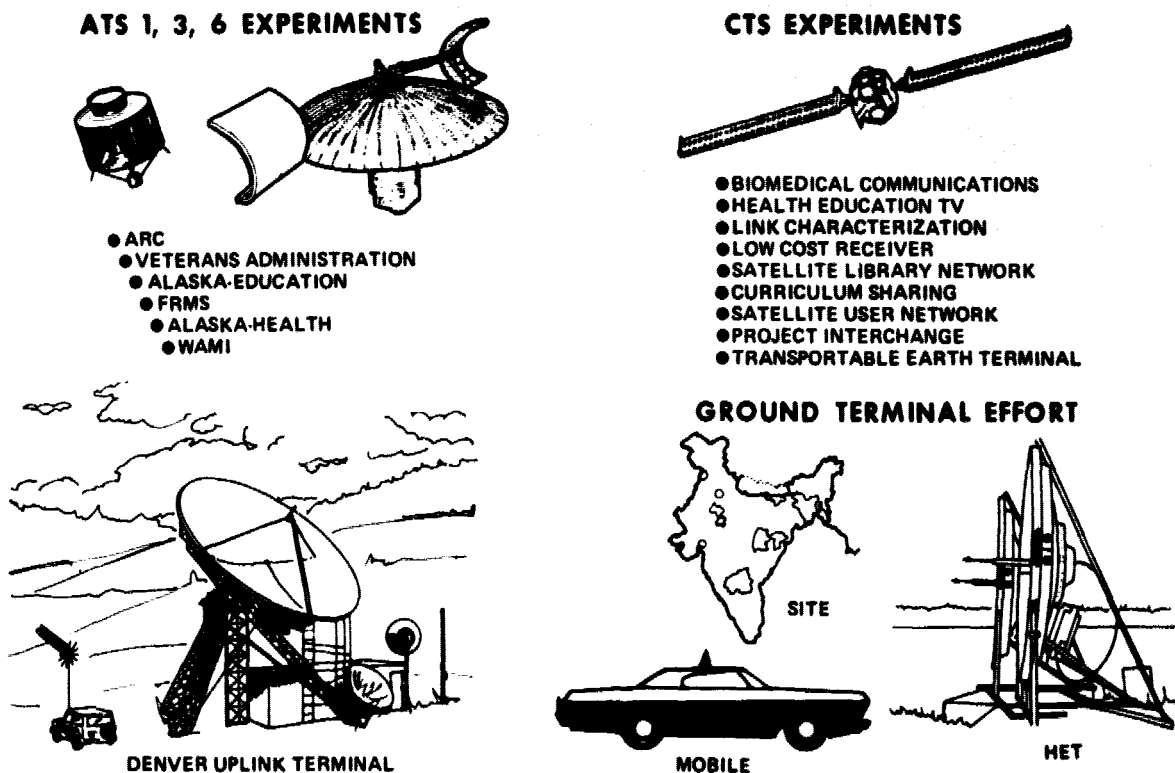


Figure 3. Previous Experimental Activities

Loop back, half duplex, full duplex, and three terminal multiple access configurations can be employed. Satellite transponder non-linearity, plus power and bandwidth limitations, limit multiple access capabilities. The VHF operating frequencies for the spin stabilized Applications Technology Satellites are shown in Table 1. These frequencies were selected because they are compatible with frequencies employed for spacecraft tracking, telemetry and command (TT&C) and conventional hardware can readily be supplied for small mobile terminals.

TABLE 1
ATS-1, -3 VHF FREQUENCIES (MHz)

Half Duplex Mode		Full Duplex Mode	
Uplink	Downlink	Uplink	Downlink
149.220	135.600	149.195	135.575
		149.245	135.625

The VHF satellite repeater performance is indicated in the appendix in Table B-7. A single duplex voice channel is typical of the traffic handled by this frequency translation repeater.

ATS-6

NASA's ATS-6 is a geostationary spacecraft that can be used for a variety of communications experiments. The communication system of this spacecraft includes a parabolic reflector antenna of 9 meter diameter, a composite

multifrequency antenna feed assembly, a multiple frequency transponder, and two propagation experiments. The communication system provides a high effective radiated power making possible the utilization of small inexpensive receiving terminals for ships, aircraft, and ground stations. It has been used for mobile experiments at L-Band and for broadcast to 3 m antennas at S-Band.

The transponder's characteristics are summarized in the appendix in Table B-8. It can receive and/or transmit at VHF, UHF, L-Band, S-Band, C-Band and K-Band.

CTS

The joint United States and Canada Communications Technology Satellite (CTS) program is exploring the communications potential of the 12/14 GHz region. The CTS provides TV transmission at 12 GHz from the satellite to low cost ground terminals and TV transmission at 14 GHz from transportable and low cost fixed terminals to the satellite. The CTS allows experiments with audio broadcasts, two way telephony, and wideband data links.

The CTS uses low cost ground TV transmission stations equipped with a 3.0 m dish to broadcast from remote areas, and uses remote TV receivers.

More detailed engineering information on the existing and proposed satellites is given in the appendices.

Additional Information

People desiring more information can call or write Dr. Edward A. Wolff, Code 950, NASA/Goddard Space Flight Center, Greenbelt, MD 20771, 301-982-2265.

APPENDIX A

PUBLIC SERVICE COMMUNICATIONS SATELLITE

- PSCS System Capability
- Spacecraft Parameters
- Ground System Parameters
- Ku-Band Up-Link
- Ku-Band Down-Link
- UHF Up-Link
- UHF Down-Link
- Ku-Band Performance

NORMAL CONFIGURATION

The Video Program Originating Station would normally transmit 200 watts through a 3 meter dish on the Up-Link. Video Receive Terminals would use 1.8 meter dishes with an optional 1 watt transmitter for audio talk back to the 3 meter dish at the origination site. An origination site with a 1.8 m dish would require a 500 W transmitter.

TABLE A-1
PUBLIC SERVICE COMMUNICATIONS SATELLITE SYSTEM
CAPABILITY (DOWNLINK)

Factor			UHF 866-870 MHz (CONUS Beam)	Ku-Band 11.7-12.2 GHz	
				Regional	Spot
Number of Beams	Fixed		1	4	3
	Steerable		0	0	2
Spacecraft:					
Antenna Gain (on Axis)	dB		29.1	35.9	41.4
Transmitter Power Per Beam	Watts		300	100	30/100
EIRP	dBW		53.9	54.9	52.2/57.4
Downlink Beamwidth	N-S	Deg	3.6	2.8	1.2
	E-W	Deg	6.6	1.8	1.2
Number of Transponders (Spare)			1	8 (4) at 100 Watts 8 (3) at 30 Watts	
Max Power Consumption	Watts		750	1250	
Power Generated	Watts		2400		

TABLE A-2
SPACECRAFT PARAMETERS

BEAM			RECEIVE					TRANSMIT				
	Band	Aper. (m)	B.W. (Deg)	Gain FOV (dB)	NF (dB)	Loss (dB)	G/T ⁽¹⁾ (dB)	B.W. (Deg.)	Gain FOV (dB)	Power (Watts)	Loss (dB)	EIRP (dBW)
Regional	Ku	.6x1.3	2.4x1.5	34.5	4.5	1	4.1	2.8x1.8	32.9	100	1	51.9
Alaska/Haw/ Carib	Ku	1.8	1.0	39.5	4.5	1	9.1	1.2	37.9	30	1	51.7
Spots	Ku	1.8	1.0	40.0	4.5	1	9.6	1.2	38.4	30/100	1	52.2/57.4
CONUS	Ku	.6x.2	2.5x6.5	28.9	4.5	1	-1.5	3.0x8.0	27.3	30	1	41.1
CONUS	UHF	7x3.1	3.8x7.0	25.6	3	1	-4.4 ⁽²⁾	3.6x6.6	26.1	300	0.5	50.9
NOTES (1) $4.5+1 = 5.5$ dB Effective NF = $740^{\circ}\text{K}+290^{\circ}\text{K} = 1030^{\circ}\text{K}$, Use $T_{SYS} \approx 1100^{\circ}\text{K}$ (2) $3.0+1 = 4.0$ dB Effective NF = $440^{\circ}\text{K}+530^{\circ}\text{K} = 910^{\circ}\text{K}$, Use $T_{SYS} \approx 1000^{\circ}\text{K}$												

TABLE A-3
GROUND SYSTEM PARAMETERS

		Ku-BAND				UHF		
	Units	Receive	Transmit (Audio)	Receive	Transmit (Video)	Transmit Mobile	Transmit Portable	Receive Mobile & Portable
Ant Diameter	m	1.8	1.8	3.0	3.0	—	—	—
Ant Gain	dB	44.5	46.0	48.5	50.0	3*	3*	3
Loss	dB	0.5	1.0	0.5	1.0	—	—	—
System Temp.	$^{\circ}\text{K}$	715	—	715	—	—	—	500
Ground G/T	dB/ $^{\circ}\text{K}$	16	—	20.0	—	—	—	-24
XMTR Power	W	—	1.0	—	200	20	10	—
EIRP	dBW	—	45.0	—	72.0	16	13	—

*This may be either RCP or linear with 6 dB gain.

TABLE A-4
Ku-BAND UP-LINKS

	Units	Video	Audio
Frequency Range	GHz	14.0-14.5	14.0-14.5
Ground EIRP	dBW	72	45
Path Loss	dB	207.3	207.3
Polarization & Pointing Loss	dB	1	1
Spacecraft G/T (Regional FOV)	dB/°K	4.1	4.1
Carrier to Noise Density	dB-Hz	96.4	69.4
Carrier to Noise in 30 MHz	dB	21.6	—
Threshold	dB	13	—
Margin Above Threshold	dB	8.6	—

TABLE A-5
Ku-BAND DOWN-LINKS

	Units	Video	Audio
Frequency Band	GHz	11.7-12.2	11.7-12.2
S/C EIRP (FOV)	dBW	51.7	18.7
Path Loss	dB	206	206
Polarization & Pointing Loss	dB	1	1
Ground G/T	dB/°K	16.0	20.0
Ground Carrier to Noise Density	dB-Hz	89.3	60.3
Carrier to Noise in 25 MHz/50 kHz	dB	15.3	13.3
Threshold	dB	11	10
Margin Above Threshold	dB	4.3	3.3

TABLE A-6
UHF UP-LINK

	Units	Mobile	Portable
Ground EIRP	dBW	16	13
Path Loss	dB	183.6	183.6
S/C – G/T (FOV)	dB/°K	–4.4	–4.4
S/C – C/N ₀	dB-Hz	56.6	53.6

TABLE A-7
UHF DOWN-LINK

	Units	Mobile & Portable
S/C EIRP (FOV)	dBW	50.9
Path Loss	dB	183.6
Ground G/T	dB/°K	–24
Ground C/N ₀	dB-Hz	71.9
C/N ₀ for Data Channel	dB-Hz	40
120 Data Channels	dB	21
Required Data C/N ₀	dB-Hz	61
C/N ₀ for Voice Channel	dB-Hz	50
40 Voice Channels	dB	16
Required Voice C/N ₀	dB-Hz	66
Required Data & Voice C/N ₀	dB-Hz	67
Margin	dB	4.9

TABLE A-8
Ku-BAND PERFORMANCE

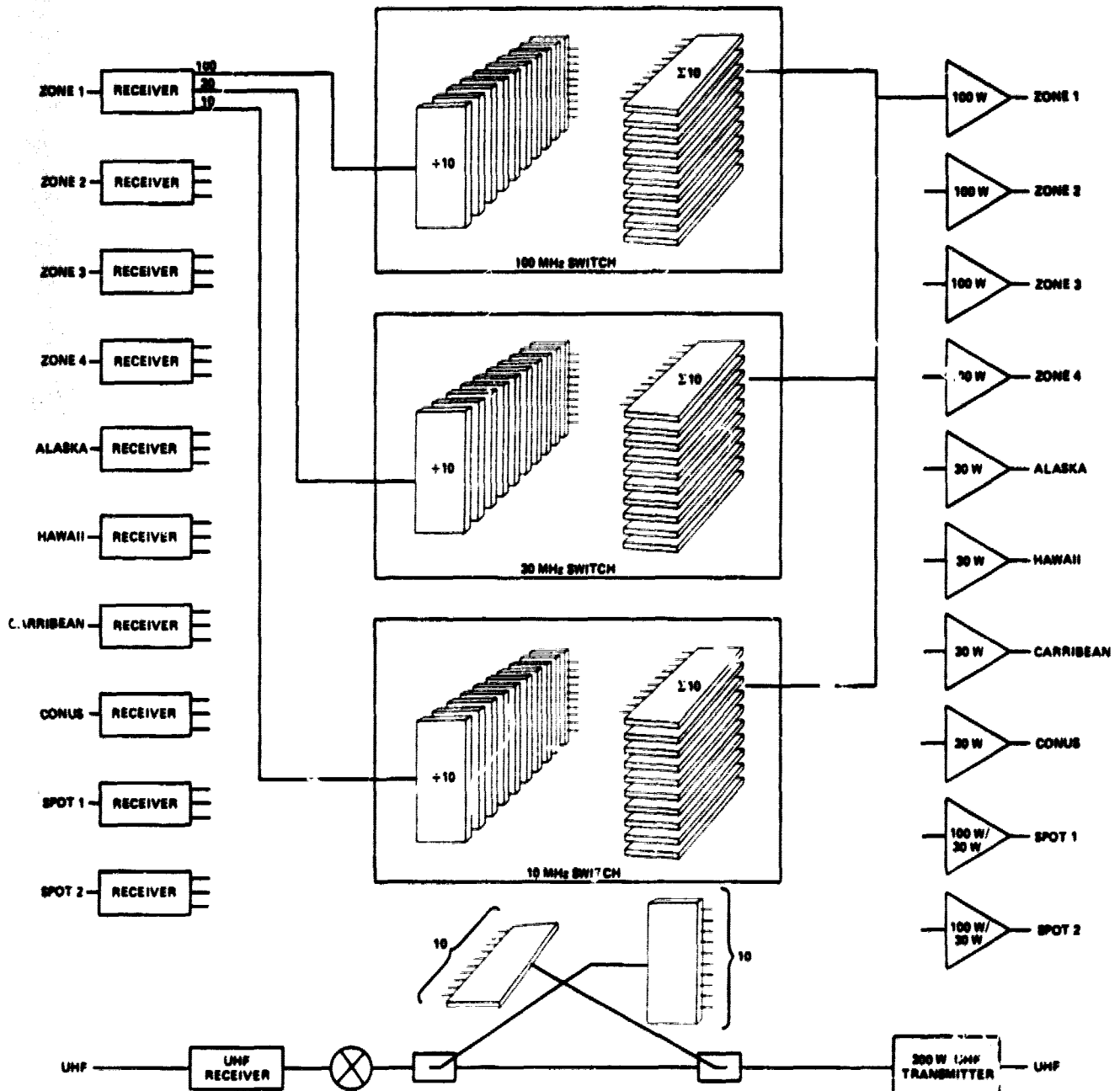
	Units	1.8 m Video	3 m Audio
C/N ₀ Uplink	dB-Hz	96.4	69.4
C/N ₀ Downlink	dB-Hz	89.3	60.3
Resultant C/N ₀	dB-Hz	88.5	59.8
Bandwidth	MHz	25	.05
Resultant C/N _T	dB	14.5	16
Baseband B.W.	MHz	4.2	.005
Δf _{Peak}	MHz	10	.015
Output TT/N _T ⁽¹⁾	dB	30.9	33.1
WTG & PRE-EMPH	dB	10.2+6 ⁽²⁾	-2.6 ⁽³⁾
Output S/N	dB	47.7	30.5

(1) $TT/N_T = \frac{3}{2} \left(\frac{\Delta f_{PK}}{BBBW} \right)^2 \left(\frac{B_{IF}}{BBBW} \right) C/N_T$

(2) CCIR Noise WTG = 10.2 dB With or Without Pre-emphasis RMS Video + SYNC to P-P Video $\Rightarrow$ 6 dB

(3) CCIT Noise WTG With 75 μsec De emphasis $\Rightarrow$ -2.6 dB in 5 kHz BW

PSCS TRANSPONDER



APPENDIX B

ATS 1 and 3

These categories are listed and defined in Table B-1. Primary objectives of the SHF (C-Band) communications experiment were to: (1) evaluate wideband transmission techniques; (2) investigate polarization and propagation phenomena; and (3) provide a communications transmission capability in support of other applications technology satellite experiments. Major VHF communications objectives were to demonstrate the feasibility of continuous air-to-ground and ship-to-shore voice communications through a satellite. The satellite VHF transponder also provided the opportunity to: (1) evaluate the feasibility of a meteorological network in which data from small unmanned stations are collected at a central station for dissemination to all interested stations within the satellite coverage area; (2) investigate the feasibility of VHF navigation systems using satellites; and (3) study the practicality of disseminating time via a VHF satellite.

TABLE B-1
EXPERIMENT CATEGORIES

Number	Description
1	VHF & SHF Radio Communications and Propagation
2	Meteorological Concepts, Applications and Techniques
3	Navigation and Position Location Techniques
4	Despun Antenna Systems
5	Measurements of the Earth Environment
6	Technology Applicable to Spacecraft Stabilization and Stationkeeping
7	Miscellaneous Aspects of Spacecraft Design

Two active repeater satellites employing spin stabilization, ATS-1 and ATS-3, were launched in 1966 and 1967 respectively.

The primary earth terminals involved in the SHF communications experiments conducted with the spin stabilized Applications Technology Satellites are listed in Table B-2. The NASA terminals included crossed dipole arrays for VHF experiments and tracking, telemetry and command (TT&C). Other terminals include fixed and semi-fixed earth terminals, aircraft terminals, shipborne stations, ocean buoy

TABLE B-2
NASA EARTH TERMINALS

Location	Sponsor	Antenna Diameter (m)
Rosman, North Carolina	NASA	30
Mojave, California	NASA	13
Cooby Creek, Australia	NASA	13

data platforms, and various fixed and mobile land-based data platforms providing information on earth resources. Terminal locations are widely scattered over portions of the world having visibility of ATS-1 and ATS-3. Entities, in addition to NASA, providing VHF terminals include the Environmental Science Services Administration (ESSA) of the U.S. Department of Commerce, the Federal Aviation Administration, Office of Naval Research, Aeronautical Radio Incorporated (ARINC), Hughes Aircraft, various major commercial airlines, and a number of foreign countries.

The NASA VHF operating frequencies for the spin stabilized Applications Technology Satellites are shown in Tables B-3 and B-4.

TABLE B-3
SHF COMMUNICATIONS FREQUENCIES (MHz)

Frequency Translation Mode			Multiple Access Mode		
Uplink	Downlink	Beacon	Uplink	Downlink	Beacon
6212.094	4119.599	4135.946	6212.294 to 6217.694	4119.599	4119.599
6301.050	4178.591	4195.172	6301.250 to 6306.650	4178.591	4178.591

TABLE B-4
ATS-1, -3 VHF FREQUENCIES (MHz)

Half Duplex Mode		Full Duplex Mode	
Uplink	Downlink	Uplink	Downlink
149.220	135.600	149.195	135.575
		149.245	135.625

Basic signal processing techniques employed with the spin stabilized Applications Technology Satellites, when operated in the SHF multiple access mode, are described in Table B-5.

TABLE B-5
SHF SIGNAL PROCESSING FOR SHF MULTIPLE ACCESS MODE

Multiple Access/ RF Modulation	SSB on uplink and PM on downlink
Ground Demodulator Performance	Threshold estimated at 10 dB C/N based upon employing conventional discriminators
Rosman Receive Carrier-to-Noise	16.7 dB employing 2 TWTs on ATS-1 and a 12-MHz IF bandwidth
Rosman Receive Margin	6.7 dB

A second SHF communications mode configures the spacecraft repeater as a standard frequency translation transponder. Signal processing employed for operation in this mode is shown in Table B-6. Both television and multi-channel voice traffic can be handled with the spacecraft configured in this manner.

TABLE B-6
SIGNAL PROCESSING FOR SHF FREQUENCY TRANSLATION MODE

Multiple Access	Frequency Division for a limited number of users
RF Modulation	FM
Ground Demodulator Performance	Threshold estimated at 10-dB C/N based upon employing conventional discriminators
Rosman Receive Carrier-to-Noise	14.4 dB employing 2 TWTs on ATS-1 and a 35-MHz IF bandwidth
Rosman Receive Margin	4.4 dB

The VHF satellite repeater performance is indicated in Table B-7. A single duplex voice channel is typical of the traffic handled by this frequency translation repeater.

TABLE B-7
SIGNAL PROCESSING FOR VHF REPEATER

Multiple Access	Frequency division for a limited number of users
RF Modulation	FM
Ground Demodulator Performance	Threshold estimated at 10-dB C/N using conventional discriminators
Ground Terminal Receive Carrier-to-Noise	20.1 dB with ATS-1 and a 100-kHz IF bandwidth
Ground Terminal Receive Margin	10 dB

ATS-6

The capabilities of the ATS-6 communications system are shown in Table B-8. The satellite is 3-axis stabilized and has a 9.1 m diameter paraboloidal reflector antenna for communications with small ground terminals.

CTS

To meet these objectives the United States and Canada agreed to initiate experimental programs designed to illustrate the adaptability of satellite systems to the distribution of information to sparsely settled areas. The programs are implemented by various independent experimenters who have designed experiments in two categories; those which advance space systems technology and those which demonstrate the suitability of space systems to the solution of social problems.

In the primary CTS operating mode the TV signal received at 14 GHz is translated to 12 GHz and rebroadcast through a 200 watt Travelling Wave Tube (TWT) amplifier driven by a 20 watt TWT. Simultaneously a second signal from a low cost remote terminal is received and rebroadcast by a second 20 watt TWT. The alternate operating mode is to use the 20 watt TWT driver as the final amplifier. In both modes the transponder has two uplink and two downlink pass bands, each 85 MHz wide, as shown in Figure B-1.

One of the prime objectives of the CTS program is to demonstrate the feasibility of using low cost ground stations in satellite communication systems. The motive behind this objective is twofold; first, to illustrate that broad-

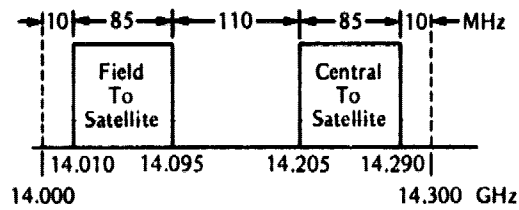
casts to remote areas are economically practical, and secondly, to encourage the participation in the experimental program of independent experimenters with limited financial resources and worthwhile experiments. Since the CTS program envisioned for the United States requires that each individual experimenter acquire the necessary ground equipment for his experiment, the availability of low cost ground

terminals influences the number of potential experimenters. The ground stations are configured to use commercially available components. The CTS ground terminals are equipped with a 2 m to 3 m dish and a tunnel diode amplifier to provide the capability for TV reception from the CTS. A summary of the terminal characteristics is given in Table B-9.

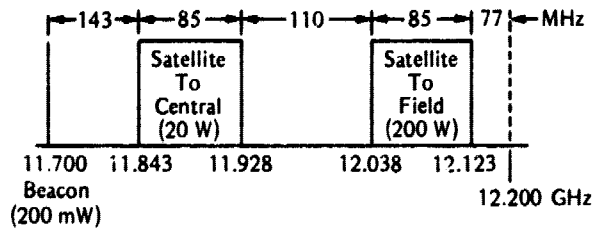
TABLE B-8
COMMUNICATIONS SUBSYSTEM CHARACTERISTICS

Mode	Nominal Frequency (MHz)	Bandwidth (MHz)	Polarization	Antenna Field of View (Degrees)	Peak Antenna Gain (dB)	Receiver		Transmitter		
						Min G/T Over FOV (dB°K)	G/T (Peak) (dB°K)	Transmitter Output Power (Watts)	Min EIRP Over FOV (dBW)	EIRP (Peak) (dBW)
9 Meter C-Band Receive	6350 6150 5950	40 12	Linear	0.4	49.0	10.5	13.5			
9 Meter C-Band Transmit	3750 3950 4150	40	Linear	0.4	46.0	—	—	21.0	51.5 (1) 47.2 (2)	54.5 (1) 50.2 (2)
Horn C-Band Receive	6350 6150 5950	40 12	Linear	20	16.5	-20	-17	—	—	—
Horn C-Band Transmit	3950 3750 4150	40	Linear	>20	16.6			21.0	25.0 (1) 20.7 (2)	28.0 (1) 23.7 (2)
	3950	500	Linear	>20	16.7			20.0		
9 Meter S-Band Receive Scan	2250	40	Right-Hand Circular	13.2 (3)	40.5	—	—	—	—	—
9 Meter S-Band Transmit on Axis	1800	12	Right-Hand Circular	—	39.5	—	—	20.0	—	50.5
9 Meter S-Band Transmit Scan	1800	12	Right-Hand Circular	13.2 (3)	39.0	—	—	20.0	48	—
9 Meter S-Band Receive on Axis	2250	12 40	Right-Hand Circular	—	40.5	—	9.5	—	—	—
9 Meter UHF Transmit	850	40	Right-Hand Circular	3.0	33.0	—	—	80.0	48.0	51

(1) Single Carrier Operation (2) Dual Carrier Operation (3) This is a 13.2 Degree Plane including the 2 Axes.



TRANSMISSION TO SATELLITE (UP-LINK)



TRANSMISSION FROM SATELLITE (DOWN-LINK)

Figure B-1. CTS Frequency Plan

TABLE B-9
SUMMARY OF TERMINAL CHARACTERISTICS
(12-14 GHz)

Terminal	Characteristics							
	Antenna			RCVR		Figure of Merit G/T, dB/°K	Max. Transmitter Power, W	Antenna Control
	Diam	Peak Gain, dB	Beamwidth 3 dB	Type	Noise Temp. °K			
Control (Ottawa)	9.1 m	57	0.2°	Uncooled paramp	200	32.8	200	Fully steerable auto-track
TV remote	3.0 m	49	0.5°	Uncooled paramp	200	22.8	1200	Step-track
TV receive only and two-way voice	2 m	47	0.7°	Tunnel diode amplifier	670	16.6	20	Manually adjustable
Two-way voice and/or FM sound broadcast receive	1 m	38	1.8°	Tunnel diode amplifier	670	8.2	20	None (fixed)



PUBLIC SERVICE COMMUNICATIONS SATELLITE EXPERIMENT

TITLE
OBJECTIVE
JUSTIFICATION
BACKGROUND
APPROACH
GROUND TERMINALS (TYPES & LOCATIONS)
REMARKS
PRINCIPAL INVESTIGATOR ORGANIZATION ADDRESS TELEPHONE

NOTE: If additional space is required please use the reverse side.